DOCUMENT RESUME

ED 087 555 PS 007 057

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TITLE	An AID-4 Analysis of Maternal Antecedents to Locus of Control - Internal (LoC-1) at Age 60 Months.
SPONS AGENCY	National Inst. of Education (DHEW), Washington, D.C.
PUB DATE	Aug 73
NOTE	15p.; Paper presented at the Annual Convention of the American Psychological Association (81st, Montreal, Canada, August 27-31, 1973)
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	*Early Childhood; *Locus of Control; Mothers; *Multiple Regression Analysis; *Parent Influence; *Predictive Ability (Testing); Research Methodology; Sex Differences
IDENTIFIERS	St. Louis Baby Study

ABSTRACT

This study reports an attempt to explore within a heterogeneous population the pattern of influence which selected maternal traits exert on internal locus of control at age 5 years. Information on the relevant variables was retrieved from the computer-based data bank of the St. Louis Baby Study. The maternal traits used for prediction included the mother's age, a measure of authoritarianism, race, IQ, level of education, a measure of anxiety, and a measure of the stimulation value of the home. Locus of control scores were available for the 77 children involved. A special multiple regression analysis (Automatic Interaction Detector, AID) was used. A brief discussion of the substantive results is followed by an extended discussion of the AID analysis. (ST)

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AN AID-4 ANALYSIS OF MATERNAL ANTECEDENTS TO LOCUS OF CONTROL - INTERNAL (LoC-I) AT AGE 60 MONTHS[1,2]

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INTRODUCTION

Traditionally the performance of children in elementary school has been formulated as the consequence of mental ability. In turn, mental functions have been largely confined to the measurable intellectual skills generically known as the IQ. Theoretically, personality factors have been acknowledged, but the comparative complexity of theory in this domain, together with a lack of easily administered instruments, has led to their neglect.

One of the more useful concepts in the personality domain is that of reinforcement in social theory and its consequences for human behavior. As set forth by Rotter (1966) the concept states that personality characteristics can be understood as the consequences of patterns of social reinforcement generated by human interaction. Individuals, it is reasoned, perceive that their attempts to perform and achieve seem to fail or succeed due to factors they can or cannot control. Since that time the concept has developed further. A distinction has been made in the site or locus of individuals' sense of control, and has been formulated in recent years as internal or external. Internal locus of control (LoC-I) is the state in which people believe that

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[1]Paper presented to Division Five of the American Psychological Association, Montreal, Que., 1973.

[2]This research has been supported by the National Institute of Education

[3]We wish to express our thanks to Professor Janos Koplyay for his courtesy and assistance in facilitating our use of the AID-4 program.

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effectiveness and assumption of responsibility for success and failure lies within them. In contrast, external locus of control (LoC-E) prevails in individuals who believe that things other than their own efforts, luck, they, the world, for example, play the dominant role in human affairs (Lefcourt, 1966). This concept is essentially an aspect of a theme basic to the life orientation of Western man, the concept of mastery (Battle & Rotter, 1963). In the lives of children the principle expression of mastery lies in meeting the developmental task of academic achievement. Buck and Austrin (1971), for example, have found that internal LoC is more likely to be found in achievers than in underachievers.

A topic of emerging significance has been the search for antecedents to the patterns of internal and external LoC (Lefcourt, 1966), with a view to manipulating and increasing internality (Reimanis, 1971). Leads to date have come from Bartel (1971) who has pointed out that social class effects increase with age among elementary school children, and that there are patterns of influence within levels of social class. A second lead has come from Reimanis (1971) indicating different patterns of LoC in boys and girls. Reimanis has also shown that home background affects LoC. Within that setting McDonald (1971) has identified by retrospective means the role of maternal traits nurturance, expectations, and pressures in the development of LoC. Buck and Austrin (1971), have also shown that LoC levels and concurrent maternal attitudes are related. Elsewhere in the now extensive literature (Throop & McDonald, 1971) on LoC the work of Entwhistle and Greenberger (1972) makes a strong case for seeing the role of salient factors as a complex rather than simple matter. By way of illustration we may observe that variables exist at levels; that is, there may be effects traceable to ages of mothers so

that young mothers differ from older mothers in the way they exert influence on the personality traits of children.

A procedural development has been the refinement of tests which permit the explanation of locus of control, internal and external, in children. The instrument used in this investigation was developed by Delys and Stephens (1971) and modified for use in the St. Louis Baby Study. It consists of 16 open-ended statements with four focal subjects selected by the authors for the child to relate his response to; e.g., you, other children, mothers, fathers. The instrument was administered orally to about 300 children at age five years. The LoC scale has been applied within the diversity of social and intellectual backgrounds found in the 1966 cohort of the St. Louis Baby Study, some of whom are the subjects of this report.

METHOD

This study reports an attempt to explore within a heterogeneous population the pattern of influence which selected maternal traits exert on Internal Locus of Control (LoC-I) at age 60 months. With this formulation in mind, information on the relevant variables was retrieved from the computer-based data bank of the St. Louis Baby Study.

The maternal traits selected for use as predictors were as follows:

Maternal age is the age at the time of delivery of probands in 1966-67.

AFI_{68} is a measure of authoritarianism in family ideology which was administered to mothers during confinement. The scale was developed by Ernhart & Loevinger (1969).

Race is a classification as non-white and white, the relevant ethnic grouping in the St. Louis metropolitan area.

Anxiety is the score on Bendig's (1955) revision of the Taylor anxiety scale, administered six months post partum.

IQ is the score on the Quick Test (Ammons, 1962) administered to mothers at child age two years.

Education is a rank value representing level of completed schooling at child age three years, 1=elementary school, 2=part high school, 3=high school graduate, 4=part college, 5= college graduate.

Stimulation is a measure of the amount of mother structured experiential stimulations. This predictor was constructed by combining three of six subscores on Caldwell's (1971) STIM test, a measure of the stimulation value of the home. This measure was obtained at child age four years.

Subjects. The number of boys and girls having complete information on the above predictor variables and the criterion, LoC-I, was 40 boys and 37 girls. As Table 1 shows the boys and girls selected were generally similar to each other as well as to the larger cohort from which they were drawn. Nevertheless, because of previous research by Reimanis (1971) demonstrating the different effects of the socializing process on boys' and girls' LoC-I scores, the analyses were performed on the separate sex groups instead of the pooled sample.

I N S E R T T A B L E 1 A B O U T H E R E

Statistical procedures. The data were explored by submitting them to an AID (Automatic Interaction Detection) analysis. AID originated from

from the OSIRIS package of the University of Michigan; the version AID-4 is a refinement of AID by Koplyay in 1971. AID-4 is like a stepwise regression program but employs a nonsymmetrical branching process, based on variance analysis techniques, to subdivide the sample into a series of subgroups which maximize prediction of the dependent variable. The independent variables need not be quantitative and can be qualitative categories. When quantitative predictors are used they can be categorized into intervals of unequal length. The assumption of linearity and additivity inherent in conventional regression techniques are not required.

More technically, the AID-4 program operates by finding the predictor variable which when dichotomized will yield the lowest within group sum of squared deviations for the dependent variables. Essentially this is the dichotomization which accounts for more of the variance of the dependent variable, (i.e., has a larger correlation with the dependent variable) than any other dichotomization based on grouping the categories of a single predictor into two groups. Once this first dichotomization is complete, the AID-4 program searches for the next group with the now largest within group sum of squared deviations for the dependent variable. When this group is identified the splitting process as above is repeated i.e., AID-4 finds the predictor variable which when dichotomized will yield the lowest within group sum of squared deviations for the dependent variable. Searching and splitting continue so long as an eligible group has at least the specified minimum number of cases and a larger within group sum of squared deviations than a specified minimum proportion of the original sum of squared deviations. Processing stops when the reduction of within group variance is not reduced by some minimum proportion of the total sum of squares or the number of groups exceeds a preset

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maximum.

As an option the program arranges the groups into a branching "tree" which represents the effectiveness of each predictor variable and its interacting pattern with the other predictor variables. Another important and invaluable option is that of selecting subjects randomly and performing a single or double cross-validation.

RESULTS

Results of the AID-4 analysis for boys are presented in Figure 1. Of the original seven predictors three were discarded - race, level of education and stimulation. Of the four retained predictors statistical significance is greatest for AFI_{68} - the authoritarian ideology measure, and for maternal intelligence - the QT score. Anxiety is significant for the high score branch of the tree, but delivery age does not increase the R^2 value to a statistically significant degree.

INSERT FIGURE 1 AND 2 ABOUT HERE

In the case of girls (Figure 2) race, stimulation, and QT score were discarded. Among the useful predictors were delivery, age, and education, with anxiety contributing to the high side of tne tree, and AFI_{68} contributing to the low side; but, without statistically significant increments in R^2. The trees for boys and girls are similar in the number of groups generated, the pattern of the splits, the absence of exponentials in the interactions, roughly comparable R^2 values at each split, and in using three of five predictors commonly. They differ in the order of importance of each predictor and in the selection of a variable to represent maternal intelligence level. For the boys the QT score was chosen; for the girls

the education level was retained.

Validation. The second part of the results is a validation of the AID-4 derived models. The AID-4 variables for boys and girls were studied using the continuous predictor variables in a standard iterative regression program (MULR-05) described by Ward & Jennings (1973) and by Kelly, Beggs, & McNeil (1969). Validation took the form of attempting to recapture the R^2 values of the parsimonious AID-4 generated regression models through the MULR-05 program and by making appropriate comparisons.

The regression models constructed for this purpose were as follows:

The full model of a simple linear combination of the original variables.

$$Y_{LoC} = a_0U + a_1Age + a_2AFI_{68} + a_3Race + a_4Anxiety + a_5QT + a_6Education + a_7Stimulation + E$$

A restricted boys' model of a simple linear combination of the retained variables from the AID-4 analysis of the boys' sample.

$$Y_{LoC} = a_0U + a_1AFI_{68} + a_2QT + a_3Anxiety + a_4Age + E$$

A restricted girls' model of a simple linear combination of the retained variables from the AID-4 analysis of the girls' sample.

$$Y_{LoC} = a_0U + a_1Age + a_2Education + a_3Anxiety + a_3AFI_{68} + E$$

The AID-4 boys' model of a linear combination of unique and interaction variables.

$$Y_{LoC} = a\ U + a_1AFI_{68} + a_2QT + a_3Anxiety + a_4Age + a_5(AFI*QT) + a_6(AFI_{68}*QT*Anxiety) + a_7(AFI_{68}*QT*Age) + E$$

The AID-4 girls' model of a linear combination of unique and interaction variables.

$$Y_{LoC} = a_0U + a_1Age + a_2Education + a_3Anxiety + a_4AFI_{68} + a_5\ (Age*Education) + a_6(Age*Education*Anxiety) + a_7*Age*Education*AFI\ ) + E$$

Where Y_{LoC} = the internal locus of control score.

U = a vector of unit elements.

a_o-a_7 = partial regression weights whose values are calculated so as to obtain a minimum error sum of squares.

E = the vector of errors in prediction.

INSERT TABLE 2 ABOUT HERE

In Table 2 we see the R^2 values of models of LoC-I for boys and girls, together with F-test comparisons where appropriate. Model 1 for boys and girls is the original seven predictor series in simple linear form. The boys' Full model is not statistically significant (R^2 = .21) but the girls is (R^2 = .38, p=.03). Application of the AID-4 program reduced the predictors for boys to a combination of AFI_{68}, Anxiety, IQ and delivery age, and for girls to delivery age, education, anxiety and AFI_{68}. When these four-variable prediction sets were set forth in the MULR-05 program in simple linear form, that is, model 2, the boys' model 2 fell far below the full model's R^2value of .21, reaching only R^2=.13. The four factor model for girls came closer to the full seven-factor model, dropping from R^2= .38 to R^2= .35. On the other hand, when the complex AID-4 model was run in the MULR-05 regression program, that is model 3, the R^2 of the boys' AID-4 model, R^2= .21, and the girls' AID-4 model, R^2 = .39, equalled or exceeded the R^2 of both the Restricted and Full models. The F-test comparisons were all significant, however.

DISCUSSION

Our intent has been to examine the value of the AID-4 analysis in

the context of a relevant problem in child development. Our observations begin with the value of the AID-4 analysis. In the context of the currently active topic of locus of-control in children we see that the AID-4 program is quite useful as a heuristic tool. The program set aside three of seven predictors in separate analyses of five-year-old boys and girls. Within predetermined limits the AID-4 program took the four best predictors and generated a complex yet parsimonious regression model for each sex.

Our second comment arises from the decision to validate these models by means of the MULR-05 regression program. In our view validity is established as well as parsimony for the AID-4 program because R^2 values generated in both programs are quite similar. Additionally, the comparisons of several regression models revealed that the parsimonious AID-4 model was highest in predictiveness.

Our final point is that we find the AID-4 program as revised by Koplyay (1971) to be a powerful and flexible multivariate tool. It permits the search for optimal arrangements of data to be conducted in such a way that empirical rather than theoretical propositions can be introduced relatively early by the theoretician. Of course, the proviso obtains that original sets of predictors need to be chosen with care. Without some intellectual premise the AID-4 program is reduced to the level of a dull rather than a sharp tool; it can only turn out products whose value is proportional to the care used to select predictors. However, once that obvious dictum is respected the AID-4 program becomes a useful tool in the process of inquiry. It can help investigators achieve a useful degree of parsimony when exploring substantial bodies of data.

SUMMARY

Koplyay's (1971) AID-4 regression interaction program has been applied to seven predictors of locus of control. The selected traits were maternal characteristics assessed at several points in time prior to assessment of locus of control at child age sixty months. Results of the analysis are reported separately for 40 boys and 37 girls in tree-like branching schematics. The parsimonious models generated in by the AID-4 program were replicated on the regression program known as MULR-05.

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TABLE 1

DESCRIPTIVE CHARACTERISTICS OF BOYS' MOTHERS AND GIRLS' MOTHERS AND SELECTED COHORT VALUES

				Predictors					Criterion
		Delivery Age	AFI_{68}	Race(%)	Anxiety	QT	Education	Stimulation	LoC-I
=40 boys)	Mean	25.85	24.00	17..	5.20	29.32	3.05	19.15	3.91
	Sigma	5.85	7.03		4.31	4.98	.94	2.34	3.36
:37 girls)	Mean	26.02	23.94	08	4.81	40.32	3.45	19.48	4.18
	Sigma	5.84	6.77		3.69	4.28	.88	2.04	2.32
ıort ues	Mean	25.00	27.48		5.80	37.82	2.87		
	Sigma	6.75	7.84		4.41	5.86	1.00		
	N	851	831		653	668	321		

FIGURE 1

AID-4 ANALYSIS OF BOYS' INTERNAL LOCUS OF CONTROL AT 60 MONTHS

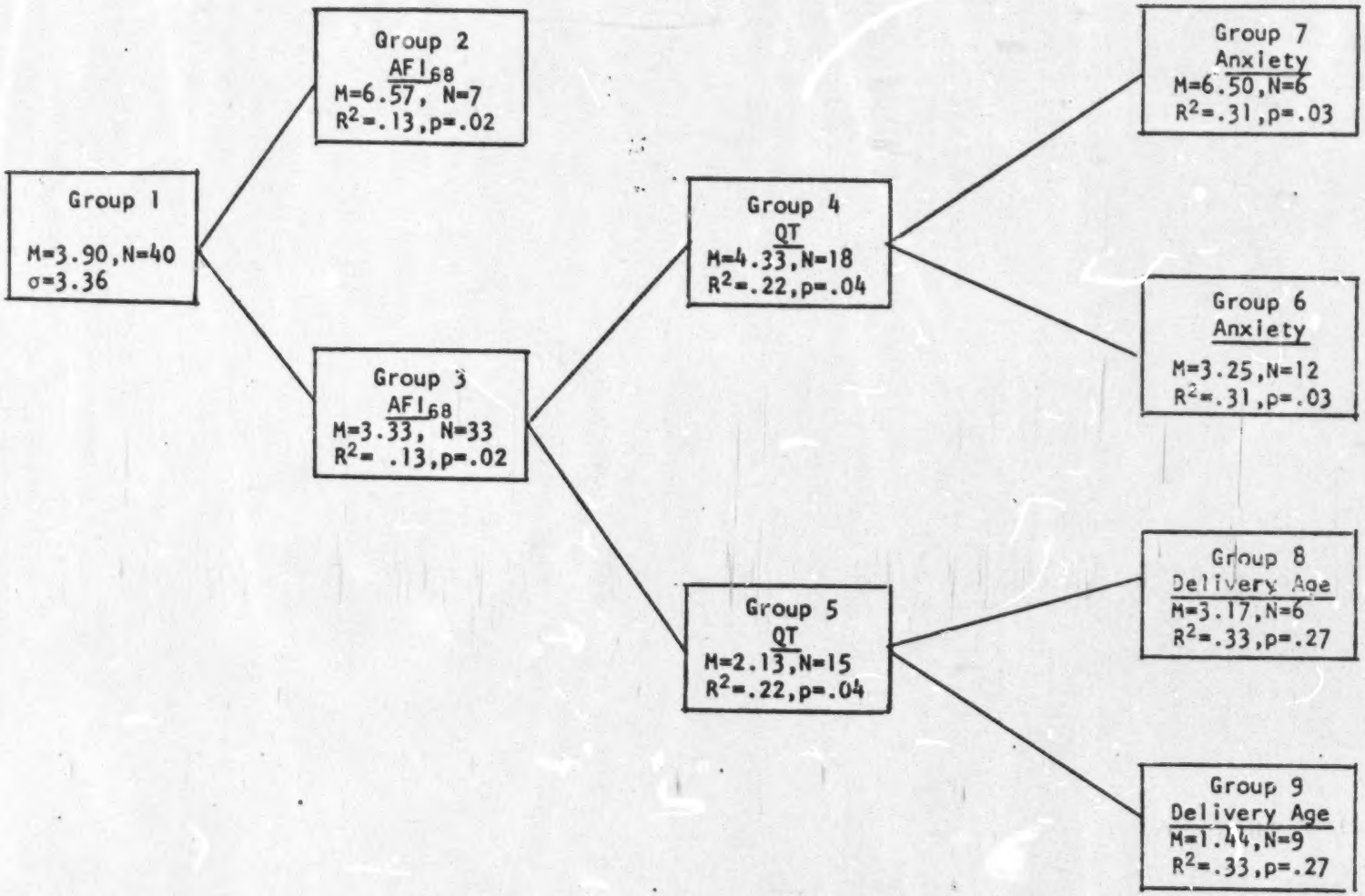

FIGURE 2

AID-4 NALYSIS OF GIRLS' INTERNAL LOCUS OF CONTROL AT 60 MONTHS

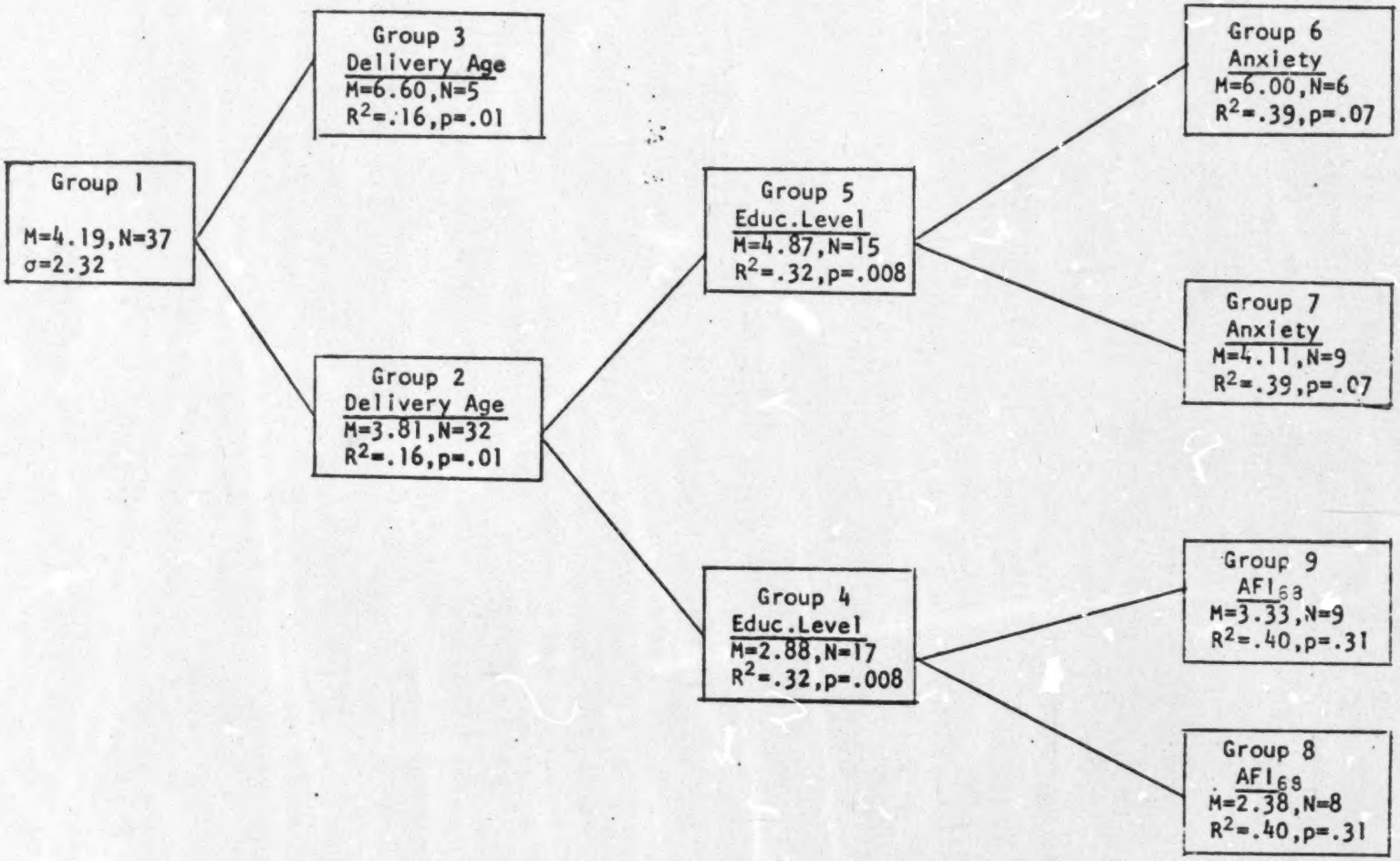

TABLE 2

COMPARISONS OF MODELS GENERATED BY AID-4 AND VALIDATED

BY MULR-05 REGRESSION PROGRAM

Model	Boys			Girls		
	R^2	F	P	R^2	F	P
1. Full Model	.211		.319*	.386		.032*
		1.06	.378		0.43	.736
2. Restricted Model	.132		.276*	.359		.005*
		1.05	.381		0.53	.710
3. AID-4 Model	.214		.307*	.307*		.029*

*Probability value for F-test between model R^2 and an $R^2 = 0.0$.